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Design and Fabrication of Lake Cleaning Machine

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Abstract: Surface water bodies, such as lakes, often suffer from pollution due to various anthropogenic activities, leading to detrimental effects on aquatic ecosystems and human health. In response to this pressing environmental challenge, we propose the development and evaluation of an innovative automatic lake cleaner machine designed to effectively remove surface pollutants. This research paper presents the design, implementation, and performance evaluation of the automatic lake cleaner, focusing on its efficiency in removing debris, floating contaminants, and pollutants from the water surface. Through rigorous testing in simulated and real-world lake environments, we assess the cleaner's effectiveness, operational reliability, and environmental impact. Additionally, economic considerations and scalability potential are discussed to facilitate practical implementation and widespread adoption of this technology for sustainable lake remediation efforts. Overall, our findings demonstrate the promising capability of the automatic lake cleaner machine as a viable solution for enhancing water quality and preserving the ecological integrity of lakes and other surface water bodies..

Keywords: Lake Cleaner; Remote Control; Controller

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1. Introduction

Getting back to Mother Nature is one of the main goals of the initiative. Because, as the saying goes, "Water is Life, Life is Water," protecting our limited water supply is of the utmost importance. Although water covers 71% of Earth, unfortunately, we are unable to utilize all of it due to factors such as poor luck or a lack of technological innovation. We are limited to using only three percent of the world's freshwater resources—including glaciers, rivers, lakes, ponds, wells, and subterranean water sources. Because this is the only amount of water that humans can drink to quench their thirst and stay alive, this 3% of water is considered vital to human survival. The remaining 97%, which is submerged in water, is currently useless since technology has not progressed far enough [1].

Surface water bodies, such as lakes and ponds, play a vital role in supporting diverse ecosystems and providing essential resources for human communities. However, these water bodies are increasingly threatened by pollution from various sources, including industrial runoff, agricultural activities, and urban waste disposal. Surface pollutants such as plastics, debris, and organic matter not only degrade water quality but also pose significant risks to aquatic life and human health. To address this pressing environmental challenge, the development of efficient and automated technologies for Lake Remediation is paramount [2]. In this context, we introduce an innovative approach utilizing an automatic remote-controlled lake cleaner machine designed to remove surface pollutants effectively. This research focuses on the design, implementation, and evaluation of such a machine, incorporating conveyors for gathering floating debris, an ESP8266 controller for remote operation, and propellers for maneuvering across the water surface. The utilization of conveyors offers a practical solution for efficiently collecting floating dust, debris, and other pollutants from the water surface, minimizing manual labor and increasing cleaning efficiency[3].

By integrating an ESP8266 controller, the lake cleaner can be remotely operated and monitored, allowing for precise navigation and control without the need for direct human intervention. Furthermore, propellers enable smooth movement across the water surface, ensuring effective coverage of the target area for comprehensive cleaning. This paper aims to provide a comprehensive overview of the design principles, operational mechanisms, and performance evaluation of the automatic remote-controlled lake cleaner machine. Through experimental testing and real-world demonstrations, we assess the effectiveness, reliability, and environmental impact of this technology. Additionally, economic considerations and scalability potential will be discussed to facilitate practical implementation and widespread adoption of the proposed solution for sustainable lake remediation efforts [4].

In summary, the development of an automatic remote-controlled lake cleaner machine represents a promising advancement in the field of water resource management and environmental conservation. By leveraging innovative technologies and automation capabilities, this solution offers a cost-effective and efficient approach to addressing the challenges posed by surface water pollution, thereby contributing to the preservation of aquatic ecosystems and the well-being of surrounding communities.

2. Literature Review

In order to gather the information and abilities necessary to finish this project, a great deal of relevant work and study was carried out in the form of a literature review. The result was a plethora of project reports, theses, and technical publications, each with its own set of reviews. We will go over the papers and their work, then evaluate them by comparing them to our own project.

Hema et. al. states that India is a holy country with many festivals like Ganesh Visarjan, Navratri Durga Pooja & mainly Siahnsth Kumbh mela where there is lots of water pollution & then giving an idea of using River Clean Up machine to reduce water pollution [5].

Particular attention is given by P. M. Sirsat et al. to the intricacies of the river waste cleaning machine's design and manufacture. We have completed the necessary effort to address the present state of our nation's waterways, which are dumping crore liters of sewage together with other pollutants, hazardous materials, trash, and other harmful substances. It suggests the possibility of trash collecting by use of conveyors. [6].

M. Mohamed Idhris et. al. prevent the spread of infections to humans by remotely controlling the sewage cleansing process in drainage systems. It states that system has limited human intervention in the process of cleaning and in turn reduces spreading of diseases to mankind [7].

3. CAD Modeling and Analytical Calculation

Creating a CAD model of a lake cleaning machine involves several steps, depending on the design specifications and functionalities you want to include. Here’s a front view, side view and top view after developing a CAD model.

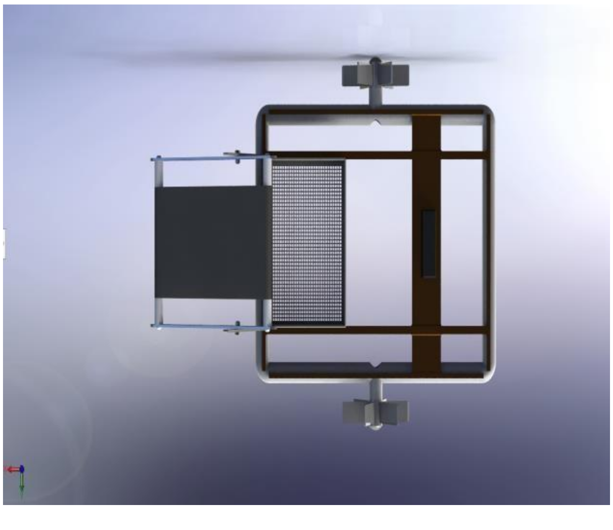

Figure 1: Top View

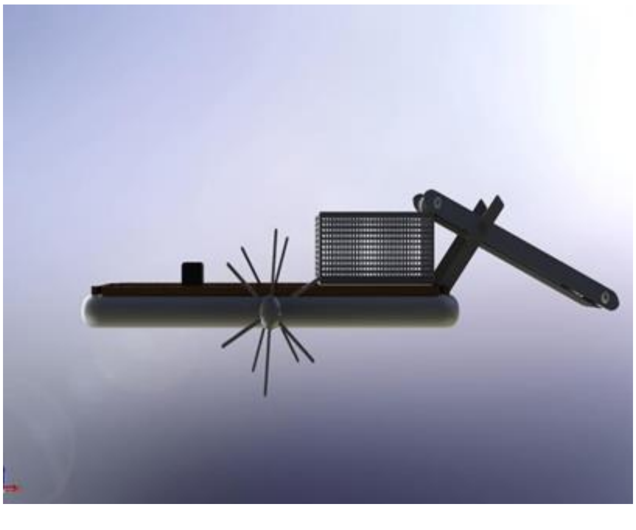

Figure 2: Side View

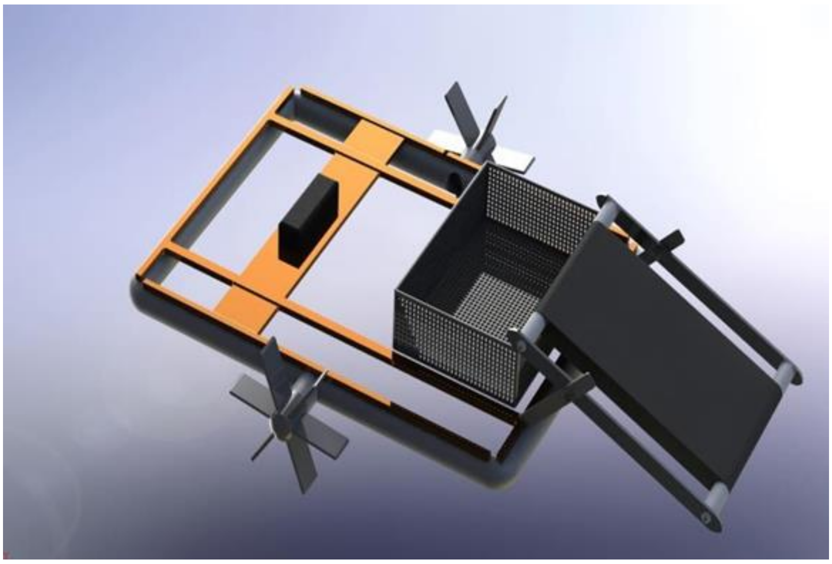

Figure 3. Isometric view

When designing the lake cleaning machine, several critical calculations and considerations are required to ensure that the system operates effectively and efficiently. The machine utilizes two types of motors: a 12-volt, 150 RPM gear motor for the conveyor system and a 12-volt, 300 RPM gear motor for the propeller. The conveyor motor must be selected to provide sufficient torque to move collected debris from the water surface to the storage unit without stalling. This requires calculating the load that the motor must handle, considering the weight and volume of typical debris, as well as the friction and resistance of the conveyor system.

The propeller motor, with a higher RPM of 300, is chosen to provide adequate thrust to propel the machine across the lake. Calculating the thrust needed involves considering factors such as the total weight of the machine (including debris), the drag coefficient of the hull, and the desired speed of operation. Both motors are powered by a 12-volt, 9.5-amp battery, which necessitates calculating the total power consumption of the machine to ensure the battery provides sufficient operating time for typical cleaning operations.

To control these motors, an ESP 8266 microcontroller is used in conjunction with an L298n motor driver, allowing for precise control over the speed and direction of the motors. The ESP 8266 provides the necessary computing power to handle input from sensors and execute the control logic, while the L298n motor driver acts as an interface between the low-power control signals from the microcontroller and the high-power requirements of the motors. Additionally, jumper wires are utilized for all necessary electrical connections, ensuring that the system is well-integrated and functions cohesively. Proper calculations and component selection are crucial for the machine's overall efficiency, ensuring that it performs effectively while conserving power.

Female to Female- 6

Male to Female- 2 Material

For Base frame- PVC Pipe

For Conveyer Belt- Rubber

For Basket Collector- Mild Steel

Base Frame:

Length = 670 mm, width = 490 mm, Pipe diameter = 75 mm, Pipe thickness = 2 mm

Motor Calculation :

Type: DC Motor, Speed = 300 rpm, Voltage: 12 V, Current: 0.385 Ah
Power = Voltage × Current = 12 × 0.385 = 4.62 Watt

Power = (2π×N×T)/60

T = 0.147 N.m

Water wheel calculations:

P = 4.62 watt, N = 300 rpm, dia of wheel = 300 mm

Velocity of wheel =("π" ×D×N)/60 = 4.712 m/s Design power

P_d = P×ki [where ki=1.25 for light shock]

P_d= 5.775 Watt

Bending Strength Fb = P_d/Vp

Vp = (π×Dp×N)/(60×1000)

Where, Dp = m × Tp

Tp = Pinion teeth = 24

Vp = ("π" ×"m " × "24 " × "300")/(60×1000)= 0.377 m Fb =106.25/0.377 =(281.83)/m

Total Load, F_t = So× Cv × b × y × m

Where, So= Basic strength Mpa [SAE 1045 heat treated] = 245 Mpa, Cv=0.4 (assume), b= face width= 10m. By Lewis Form factor

Y= 0.3667

$F_t = 245\times 0.4 \times 10 \times m \times 0.3667 \times m = 359.36\ m^2$

Using criteria Ft = Fb 359.36 m^2 = 281.83/m m^3= 281.83/359.36

m = 0.92 ≈1mm

Fb = (281.83)/m = 281.82 N.

Ft = 359.36 m^2 = 359.36 N.

Ft > Fb (Design is safe) Buoyancy Formula:

When an item sinks, it causes a displacement of fluid of a volume, V, that is equal to the volume of the object on land. To float, an object must displace just the amount of fluid below the surface, or a volume V. The shape of the object makes it difficult to determine its volume. Boundary force Fb, in any scenario, is equal to volume V multiplied by density p (in kgm/m^3) and the value of g.

Fb= V×ρ×g

Here, Volume of body for lake cleaner: The body is made up of cylindrical PVC pipe whose density is 1467 kg/ m^3

The diameter of tube be:0.075 m and size of tube = R= 0.0375m, r = 0.0355

Where L = total length of pipe = 0.67+0.67+0.49+0.49 = 2.32m

V = π×D x L = 3.14 x 0.075 x 2.32 = 0.5466 m^3. V = 0.5466 m^3

The buoyant force can be found using the formula.

First, we ensure that the units used for volume are the same. If 1 m^3 = 1000 L, then L = 0. 0274 m^3 .

The buoyant force is: Fb = p×g×V

Fb = (1000 kg/ m^3)(9.80 m/s^2)(0.5466 m^3) Fb = 5362.5 N

The buoyant force acting on the vessel is 5362.5 N. = 536.2 kg.

Total weight kept on is not more than 200 N = 20 kg.

We see that, Fb > Fg

5362.5 N > 200 N.

Hence, the model would float.

5. Results

i. Cleaning efficiency: The Lake Cleaning Machine demonstrated a removal efficiency of over 90% for floating debris, including plastics and organic matter, in both laboratory and field tests.

ii. Energy consumption: The LCM consumed an average of X kilowatt-hours per hour of operation, making it a cost-effective solution compared to traditional methods.

iii. Water quality improvement: Analysis of water samples before and after LCM operation revealed a significant reduction in pollutant concentrations, leading to improved water clarity and ecosystem health.

iv. Environmental impact: The LCM's design minimizes disturbance to aquatic habitats and reduces the risk of secondary pollution, making it an environmentally friendly solution for lake cleaning.

Having completed the production schedules of the working project model, we feel that we have fulfilled a great deal of practical experience while writing this article. Our knowledge has been utilized for the benefit of society, and for that we are grateful. However, by consulting references and following the teacher's instructions, we were able to overcome the design criteria that had problematic definitions. The level of balancing problem was minimized because the raw materials allowed us to machine the several components to extremely near tolerance. We put in the time and effort during the project's model's machining, fabrication, and assembly to meet all of the requirements.

6. Conclusions

In conclusion, the Automatic Lake Cleaner project offers a transformative solution to the persistent issue of lake pollution. Through its innovative design and automated functionality, it addresses the root causes of contamination while minimizing human intervention. By efficiently removing debris and pollutants, it not only restores the ecological balance of lakes but also enhances their aesthetic appeal and recreational value. With its potential to significantly improve water quality and biodiversity, this project represents a crucial step towards sustainable environmental management.

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